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Older Adults' Satisfaction of Wearing Consumer-Level Activity Monitors

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Abstract

There is a growing body of evidence to suggest that consumer-level activity monitors are a valid means of measuring physical activity in older adults. Understanding whether older adults are satisfied with wearing these activity monitors is an important step to ensuring that devices can be successfully implemented in clinical and research settings. Twenty-five older adults (Mean age = 72.5, Standard deviation = 4.9) wore two consumer-level activity monitors (Misfit Shine and Fitbit Charge HR) for seven consecutive days. After the week participants were asked for their views and satisfaction of wearing each device, measured in part by the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Participants were generally satisfied with most aspects of the devices, though were significantly more satisfied with the Misfit Shine. Participants were critical about their ability to adjust both the Misfit Shine and Fitbit Charge HR. Interestingly, the perceived satisfaction with the device was not associated with participants' consideration of wearing the device again. Future research needs to consider whether the design of consumer-level activity monitor is best suited for older adults.

Keywords

Activity monitor, wearables, acceptability, elderly, ageing, sensor design

Introduction

The increased availability of low-cost accelerometer technology alongside the advancement of other technologies has caused the development of low-cost consumer-level activity¹, which make up part of an ever growing market of wearable technologies.² This has led to the wide spread availability of accelerometer technology. The range of devices available to the general public vary in terms of cost, information recorded, battery life (or frequency of charging), information displayed on the device and via the support applications. Whilst these devices are now being more broadly adopted,³ a major limitation to the implementation of these devices as a measurement tool is the absence of robust scientific evidence that these devices are valid in terms of data captured.

Older adults tend to have reduced gait speeds and use walking aids, thus compromising the validity of consumer-level activity monitors.⁴⁻⁶ However, this is only one aspect of ensuring that these devices are successfully used in older adults. As the number of studies that implement consumer-activity monitors grow in older adults, we are able to glean in part the acceptability of wearing such devices through the dropout rates. Unfortunately researchers do not always clearly report such missing data or there is little context behind these numbers.^{4,5} As a result, it is difficult to determine whether older adults are satisfied with consumer-level activity monitors and whether devices can be better optimised to meet their particular needs.

Determining whether older adults are satisfied with wearing consumer-level activity monitors has previously been overlooked, though acceptance of wearing such devices is tied the ease of wearing them, with a preference for small devices attached to the wrist or ankle.^{7,8} To our knowledge only a single study has explored how older adults view consumer-level activity monitor, albeit in a single device (Fitbit One).⁹ The older adults in the study tended to agree or strongly agree with statements that the device was easy to use, useful and acceptable.

Before consumer-level activity monitors are more broadly adopted it is important to get a better understanding of older adults' satisfaction of wearing such devices. This will better enable researchers and clinicians to not only select validated devices but devices that are suitable for the target population. The aim of this study was to explore older adults' views of wearing two previously validated consumer-level activity monitors (Misfit Shine and Fitbit Charge HR).

Methods

Participants

Participants were community-dwelling older adults (aged 65-84), recruited from West Sussex, England and Co. Down, Northern Ireland. Participants were excluded if they were not independently ambulatory or used a walking aid (self-reported).

Procedure

The University of Chichester Research Ethics Committee approved this study and all participants provided informed consent prior to taking part. Following informed consent, participants were asked to complete a series of questionnaires including demographic information. Participants were then asked to wear five activity monitors over a week period, three waist worn devices (Misfit Shine and two research-grade activity monitors) were attached to an elastic belt and positioned above the right kneecap. The two wrist worn monitors (Misfit Shine and Fitbit Charge HR) were positioned on the right wrist. Participants were instructed to put the monitors on and take them off at the same time and to wear the activity monitors during waking hours, except during bathing and water-based sports. Participants were not asked to change their daily habits during the study, and were not given access to device's software or informed of additional device features. Participants were instructed not to interfere with the device or change the device location. Following a week of wearing the devices, participants returned the devices and completed additional questionnaires which included their satisfaction of the two consumer-level devices.

Measures

Demographic information, including age, gender, residential density, ethnicity, handedness, years of education, and subjective physical health complaints were taken from all participants

Assistive Device Subscale of the Quebec User Evaluation of Satisfaction with assistive Technology 2.0 (QUEST) ¹⁰ – An 8-item questionnaire developed to assess the satisfaction of using assistive technology. Participants were asked to include a comment about each item, if they did not respond 'very satisfied'. As participants were not asked to interact with the device, or utilise its data, two questions were removed (i.e. *ease of use* and *effectiveness*).

Participants were asked 'Have you ever worn an activity monitor, pedometer or similar device before?'

Participants were also asked a series of questions about what they perceived to be the best and worst feature of each device, where they would choose to wear the device and whether they would consider wearing the device again the future.

Not discussed here, additional measures were taken as part of the broader study including measures of physical function, cognitive performance, and physical activity levels.

Consumer-level activity monitors

The Fitbit Charge HR (*Fitbit, Inc., San Francisco, California, USA*) is a tri-axial motion sensor, which records activity in 60-second epochs in the general setting mode. It provides daily data in the form of steps, distance, calories, activity intensity and sleep. This brand of device has previously been used in research with an older population.^{5,6} It requires charging via a USB cable every three to four days (depending on usage). The device was set up with participant's gender, age, height, weight and hand dominance. This data can be accessed from a digital display on the device or by synchronizing the device to a companion website or smartphone application. The device was worn on the wrist.

The Misfit Shine (*Misfit Wearables, Burlingame, California, USA*) is a tri-axial motion sensor records steps, distance, calories burned, sleep quality and duration and active time. This device was selected, in part, because of its low-profile design and longevity of battery (dependent on use the battery can last approximately six months). It does not provide a digital display of data (the blank face can be activated by tapping the surface to display up to 12 LED lights that chart progress towards a daily activity goal) on the device and therefore has to be synchronised with the accompanying application to obtain the data. The device was worn on the wrist using the strap accessory and on the elastic waistband using the magnetic clasp accessory alongside two research grade devices (the Actigraph and the NL2000i). The device was set up with participant's gender, age, height and weight.

Analysis

Demographics data of the sample were reported descriptively (e.g. Means, Percentages)

Data from the QUEST was analysed in line with official guidance.¹¹ For each device, individual item satisfaction scores were presented as percentages depending whether the participants scored 1, 2, and 3 or 4 and 5. A total QUEST score (from the assistive device subscale) was calculated by creating an average score (sum of valid scores/number of valid items). Summary scores (e.g. median (Mdn) and interquartile range (IQR)) were reported for the total QUEST score, and a Wilcoxon Signed-Rank Test was used to compare scores between devices. Verbatim quotes were also reported to provide context for why participants were not satisfied with the devices. A Mann-Whitney U Test was used to analyse whether participants' satisfaction with the device predicted whether they would consider wearing the devices again.

A Directed Approach Content Analysis¹² was also performed on what participants felt was the best and worst feature of each device. Features from the assistive subscale of the QUEST (dimensions, weight, ease in adjusting, safe and secure, durability, ease of use and comfortable) were used as predetermined codes, and two researchers independently coded the responses (NF & SB). Any data that did not fit into these predetermined categories were then subsequently analysed to determine whether they represent a new category. These categories were identified as being 'appearance', 'function' and 'health'. The researchers came to a consensus between them if there were any discrepancies in coding and any responses that were too vague to code. Count scores were then tabulated.

Valid percentages were reported for the questions relating to whether participants have worn similar devices before, whether they would wear the device again and what bodily location they would like to wear the devices.

Field notes from informal conversations between the participant and their researcher were also summarised.

Data was analysed using SPSS V.23 (IBM Corporation, Armonk, New York, USA).

Results

Demographics

Participants were on average 72.5 years old (SD=4.9). Fifty-two participants (n=13) were male and 48% were female (n=12).

Previous experience of activity monitors

Only 26.1% of participants reported to have previously used an activity monitor, pedometer or similar device. Of the participants who reported previous use of such devices, two had used a heart rate monitor, two had used a pedometer with only a single participant having used a consumer-level activity monitor (i.e. Fitbit).

QUEST satisfaction scores

For both devices, the majority of participants reported that they were either 'quite satisfied' or 'very satisfied' with all features of the device (>50%). Participants were most satisfied with the weight of the Misfit Shine (100.0% 'Quite satisfied or 'Very Satisfied') and were least satisfied with the adjustment of the device (73.9% 'Quite satisfied or 'Very Satisfied'). For the Fitbit Charge HR, participants were most

satisfied that the device was safe and secure (91.3% 'Quite satisfied or 'Very Satisfied') and least satisfied with the adjustment (62.5% 'Quite satisfied or 'Very Satisfied'). See Table 1.

When exploring the open ended comments provided by participants, the most common criticism about the securing of the Misfit Shine was how easily it could be knocked out of the strap/holder. As the Fitbit Charge HR is a single unit, this was not raised as an issue. For both devices, participants found the devices 'fiddly' and difficult to put on and adjust. The Fitbit Charge HRs strap was considered 'stiff', 'inflexible' and 'rigid', with some participants commenting on how uncomfortable the device was. Participants felt that the Fitbit Charge HR was large, being described as being 'a little bulky' and 'quite deep', as well as being heavy. No comments were left for the weight or dimensions of the Misfit Shine.

On average participants were quite satisfied with both devices, with the total score significantly differed between the total QUEST subscale score of the Misfit Shine (Mdn=4.7, IQR=0.3) and the Fitbit Charge HR (Mdn = 4.3, IQR = 1.3) ($Z = -1.97$, $p = 0.048$).

Best and worst features

In using a Directed Approach Content Analysis, 10 categories were identified when exploring participants' responses to the best and worst features of each device. For the Misfit Shine, the devices comfort (n=5), appearance (n=5) and dimensions (n=5) were reported as the best features. The ease in adjusting was deemed the most frequently reported worst feature (n=4). A single participant identified that the Misfit Shine strap and buckle caused a rash (i.e. Health). The functions of the Fitbit Charge HR was most frequently reported as the best feature of the device (n=9). The dimensions was the most frequently reported worst feature of the device (n=5). For full results see Table 2.

Field notes

A number of the female participants reported developing bruises across the wrist associated when the strap of the Fitbit Charge HR caught on objects thus pulling against their arm and leaving a bruise. Comments were made to researchers that there were concerned with the security of the waist worn Misfit Shine, which would fall off and they would have difficulty locating it. Some participants also reported that they enjoyed being able to show their progress to family and friends across the week, in particular to sons and daughters who had expressed concerns over their parent's health status.

Wear location

The Fitbit Charge HR, is designed to be wrist worn, and participants most frequently reported that their preference was to wear the device on the dominant wrist (n=15, 62.5%), non-dominant (n=7, 29.2%) and non-specific (n=2, 8.3%). Comparatively, the Misfit Shine, which is designed to be worn of several locations, participants most frequently reported a preference of wearing the device on the wrist on the dominant side (n=9, 39.6%) followed by the non-dominant side (n=5, 21.7%).

Wearing the devices again

When asked whether they would consider wearing the devices again 52.4% (n=11) of participants said that they would consider wearing the Misfit Shine again, compared to the 68.2% (n=15) of participants who said that they would consider wearing the Fitbit Charge HR again. Participants opinion of wearing the device in the future did not predict satisfaction scores on the QUEST for either the Misfit Shine (U=31.50, p=0.09) or Fitbit Charge HR (U=37.00, p=0.27).

Discussion

The purpose of this study was to assess older adults' opinions and satisfaction of wearing consumer-level activity monitors. Based on the QUEST, participants tended to be relatively satisfied with all features of both the Misfit Shine and the Fitbit Charge HR. However, participants were significantly more satisfied with the Misfit Shine compared to the Fitbit Charge HR.

The feature that participants were least satisfied with was the comfort of the Fitbit Charge HR, with a third (33.3%) of participants reporting that they were 'More or less satisfied' or less. This was also reflected by participants' comments when asked about the devices worst feature. The best feature between the devices was the weight of the Misfit Shine will all participants (100%) reporting that they were either 'Quite Satisfied' or 'Very satisfied'. A common criticism of both the Misfit Shine and the Fitbit Charge HR was the ability to adjust them, with over a quarter of participants not reporting that they were 'Quite Satisfied' or 'Very satisfied'. Participants described adjusting the straps as being '*fiddly*', which is problematic in older adults where there is a documented decline in hand function.^{13,14}

Interestingly, when asked what the worst feature of the Misfit Shine, limited functionality was a common theme. The Misfit Shine is able to display a clock function and number of steps proportionate to a target through a series of flashing LED lights by tapping the device. As participants were not required to access this information, no additional training was provided to participants. In contrast, the Fitbit Charge HR has a digital display which allows participants to readily access information such as clock, heart rate and physical activity levels. Access to this information was commonly perceived as one of the best features of the Fitbit Charge HR, and informal conversations with participants support this. Previous research has identified that older adults' attitudes toward activity monitors is in part tied to perceived usefulness and personal benefits of wearing the devices.¹⁵ In fact, recent evidence suggests that increasing awareness about the functionality and purpose of the device is likely to increase acceptability of wearing the device in older adults.¹⁶ This finding could also explain why older adults were more likely to choose to wear the Fitbit Charge HR again rather than the Misfit Shine.

It is important to highlight that the findings of this study reflects the views of a limited sample of healthy older adults, and therefore may not necessarily represent the views of a broader older adult population. As highlighted above, another limitation is related to the fact the findings here only reflect the satisfaction and views of consumer-level activity monitors used exclusively as a measurement tool. Additional considerations are needed if such devices are implemented as a means to promote physical activity^{17,18} as it requires participants to interact and engage with the information collected from the device.

In considering the use of a consumer-level activity monitors in older adults it is not enough to just consider the validity of the device. Regardless of the setting, ensuring that a device is acceptable to wear is paramount to ensure that people wear the device for the duration of the measurement period, be it in a research or clinical setting. This study highlights that older adults are generally satisfied with two such consumer-level activity monitors (Misfit Shine and Fitbit Charge HR), though making devices easier to fit and adjust is something that needs to be refined for older adults. Future studies should also consider whether functions should be described to older adults regardless of whether they need to use them or not. Due to the frequent development of new activity monitors, it is unlikely that research will be able to keep up with the evaluation of the plethora of different designs. However, researchers and clinicians should consider the design features of activity monitors before implementing within older adults. Future research should not neglect the growing number of cognitively impaired people over the age of 65, which could be an important factor in determining what is acceptable.

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Conflict of Interest

There are no known conflict of interests.

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References

1. Lee J-M, Kim Y, Welk GJ. Validity of consumer-based physical activity monitors. *Med Sci Sports Exerc* 2014; 46: 1840–1848.
2. Page T. A Forecast of the Adoption of Wearable Technology. *Int J Technol Diffus IJTD* 2015; 6: 12–29.
3. Evenson KR, Goto MM, Furberg RD. Systematic review of the validity and reliability of consumer-wearable activity trackers. *Int J Behav Nutr Phys Act* 2015; 12: 159.
4. Floegel TA, Florez-Pregonero A, Hekler EB, et al. Validation of Consumer-Based Hip and Wrist Activity Monitors in Older Adults With Varied Ambulatory Abilities. *J Gerontol A Biol Sci Med Sci* 2016; glw098.
5. Paul SS, Tiedemann A, Hassett LM, et al. Validity of the Fitbit activity tracker for measuring steps in community-dwelling older adults. *BMJ Open Sport Exerc Med* 2015; 1: e000013.
6. Phillips LJ, Petroski GF, Markis NE. A Comparison of Accelerometer Accuracy in Older Adults. *Res Gerontol Nurs* 2015; 8: 213–219.
7. Bruin ED de, Hartmann A, Uebelhart D, et al. Wearable systems for monitoring mobility-related activities in older people: a systematic review. *Clin Rehabil* 2008; 22: 878–895.
8. Dakin LE, Gray LC, Peel NM, et al. Promoting walking amongst older patients in rehabilitation: Are accelerometers the answer? *J Nutr Health Aging* 2010; 14: 863–865.
9. McMahon SK, Lewis B, Oakes M, et al. Older Adults' Experiences Using a Commercially Available Monitor to Self-Track Their Physical Activity. *JMIR MHealth UHealth* 2016; 4: e35.
10. Demers L, Weiss-Lambrou R, Ska B. Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). *Assist Technol Off J RESNA* 1996; 8: 3–13.
11. Demers L, Weiss-Lambrou R, Ska B. Quebec user Evaluation of Satisfaction with assistive Technology. QUEST version 2.0. An outcome measure for assistive technology devices http://www.midss.org/sites/default/files/questmanual_final_electronic20version_0.pdf (2000, accessed 10 November 2016).
12. Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005; 15: 1277–1288.
13. Hackel ME, Wolfe GA, Bang SM, et al. Changes in Hand Function in the Aging Adult as Determined by the Jebsen Test of Hand Function. *Phys Ther* 1992; 72: 373–377.
14. Ranganathan VK, Siemionow V, Sahgal V, et al. Effects of Aging on Hand Function. *J Am Geriatr Soc* 2001; 49: 1478–1484.
15. Fausset CB, Mitzner TL, Price CE, et al. Older Adults' Use of and Attitudes toward Activity Monitoring Technologies. *Proc Hum Factors Ergon Soc Annu Meet* 2013; 57: 1683–1687.

16. Preusse KC, Mitzner TL, Fausset CB, et al. Older Adults' Acceptance of Activity Trackers. *J Appl Gerontol* 2016; 733464815624151.
17. Snyder A, Colvin B, Gammack JK. Pedometer Use Increases Daily Steps and Functional Status in Older Adults. *J Am Med Dir Assoc* 2011; 12: 590–594.
18. Yamada M, Mori S, Nishiguchi S, et al. Pedometer-based behavioral change program can improve dependency in sedentary older adults: A randomized controlled trial. *J Frailty Aging* 2012; 1: 39–44.

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Table 1. Individual item satisfaction scores for the assistive device subscale of the QUEST.

	Misfit Shine		Fitbit Charge HR	
	% subjects 'More or less satisfied' or less. (Scores 1,2,3)	% subjects 'Quite satisfied or 'Very Satisfied' (Scores 4 &5)	% subjects 'More or less satisfied' or less. (Scores 1,2,3)	% subjects 'Quite satisfied or 'Very Satisfied' (Scores 4 &5)
Weight	0.0	100.0	12.5	87.5
Ease in adjusting	26.1	73.9	37.5	62.5
Safe and Secure	17.4	82.6	8.7	91.3
Durability	10.5	89.5	9.1	90.9
Comfort	13.1	86.9	33.3	66.7
Dimensions	4.3	95.7	20.9	79.1

Table 2. The number of occurrences (n) of each theme from the content analysis of questions about the best and worst feature of each device.

	Misfit Shine		Fitbit Charge HR	
	Best Feature	Worst Feature	Best Feature	Worst Feature
Weight	3	0	1	0
Ease of Adjusting	4	4	3	1
Safe and Secure	1	3	0	0
Durability	1	1	0	0
Comfort	5	1	2	4
Dimensions	5	0	2	5
Appearance	5	2	4	2
Function	2	3	9	1
Ease of Use	0	2	5	2
Health	0	1	0	0